Experimental Periaterial Sympathectomy : Report II

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Experimental Periarterial Sympathectomy.

Report II.

By

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實驗的動脈壁交感神經切除術 (第二報告)

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Introduction.

In my first report previously published in No. 1 (the year 1924) of the Nihon-Geka-Hokan ("*Archiv fuer Japanische Chirurgie*"), I gave the results of the investigation which I had made concerning Leriche's operation for a comparatively short time, and I hope that out of the five questions raised over the matter I was able adequately to deal therein with the first question "Does the rate of blood-flow increase in the periphery after a Leriche's operation upon *arteria femoralis?*", part of the second question "If the rate of blood-flow increases, is the increase temporary or permanent?", and the third question "Is it practicable completely to denudate the outer layer of the *arteria femoralis?*".

In the present report, I propose to deal with the three following questions, namely:

1. Is the increment of blood-flow after Leriche's operation durable (the latter half of the second question of my first report)?

Since Leriche published his views concerning the effectiveness of arterial denudation, many scientists have tried the operation clinically, the result being that some of them say that its effect is lasting, while according to others it is only temporarily effectual. Arterial denudation is based on the hypothesis that the main sympathetic nerve fibres exist in the outer wall of the artery, but according to Potts "the sympathetic supply for the vessels of the lower extremity reaches the main vessels at intervals along their course, while Kramer has reached the same conclusion in regard to the upper limb. If so, will it be possible to bring about a durable increase in blood-flow at and below the part operated upon by effecting Leriche's operation at a part of the *arteria femoralis?*

The third question given in my first report, too, not yet having been fully answered, I intend to complete the investigation into the matter by reporting in this paper the result of my microscopic observation in this respect.

2. Leriche effected denudation at first to the length of 2 cms., while it was subsequently extended to 10 to 12 cms. What change in result was there owing to the change in the length of denudation?

3. What is the difference between the result of this operation and that of abdominal sympathectomy?

If the hypothesis that the vasoconstric nerve fibres of the sympathetic nerve pass mainly the outer wall of the vessels is correct, it is possible that the expansion of the peripheric vessels experienced in the case of periarterial sympathectomy is due to the cutting off of communication of the sympathetic system to the periphery; but after that nearly the same result as that which is observed when the abdominal sympathetic trunk is cut should appear. To institute comparative inquiries into the results of the two operations on the basis of the above hypothesis is a course that is necessary for ascertaining the real nature of the effects of the operation in question. Morever, if it is possible to obtain a sufficient expansion of peripheric vessels for a comparatively long time by cutting the abdominal sympathetic trunk, the latter (abdominal sympathectomy) must be regarded as a better operation that Leriche's operation, and a new method of operation for diseases of peripheric vessels.

Below is the result of the experiments made on dogs by me in my endeavour to solve the three foregoing questions.

In addition, I will advert to three clinical cases in which Leriche's operation was effected, and wind up the whole discussion by treating of the clinical value of the operation.

Experiments.

Experiments were tried in the same manner as those connected with the first problem as described in my previous report, with this exception that arterial denudation was effected to the length of from 2 to 7 centimetres.

Notice: Methods of experiment.

This was described in detail in my first report, but may be recapitulated as follows.

Experiments were made on dogs, the animals being narcotized by a hypodermic injection of urethane at the rate of 2 grammes per kilogramme of the weight of their body. After narcotization the animal was laid on its back and the hair was shaved from Scarpa's triangle on both sides down to one-third of the thigh, and after the part so shaved having been duly disinfected, a skin incision was effected on the *vasa femoralis* on one side to a length varying between 10 and 12 cms. according to the size of the animal and junction of the *vena femoralis* and the *vena saphena magna* was laid bare. The same operation was made on the other side also. Then, the *vena saphena magna* was bound at a distance of from 4 to 5 cms. from the point at which it combines with the *vena femoralis*, and all the branch veins between the part thus bound and the central part were separately bound at a point as far away as possible from the point of confluence. Further, a small hole was made vertically with a pointed knife in the frontal wall of the *vena saphena magna* close to the point at which it combines with the *vena femoralis*. A thin string was passed under the *vena femoralis* on the central side near the point of combination (confluence) of the *vena femoralis* and the *vena saphena magna*.

The outer wall of the *art. femoralis* was next denuded at Scarpa's triangle to the length of about 2 cms..

All the operation in this connection was made according to Leriche's method.

The above preparatory operation finished, I passed on to the operation of extracting blood, the object of the latter operation being to measure the speed by causing all the blood flowing through the *vena femoralis* to flow into a peculiar pipett specially made for the purpose.

Now, the pipett was inserted into the small hole previously made in the *vena saphena magna*, and directly the obtuse end of the pipett passed through the vein valve and penetrated the *vena femoralis* and the blood began to flow into the pipett, the string passed under the *vena femoralis*, was tightened up in order to stop the blood-flow in the *vena femoralis*, so that all the blood in the *vena femoralis* would flow into the pipett, which bears graduations of $\frac{1}{10}$ c.c., and the blood-flow was depicted by means of a kimographion as it reached each $\frac{1}{10}$ c.c. until 1 c.c. was reached, when the string tightened up was relaxed and the pipett was drawn out at the same time. And this kimographion being also so constructed as to record the passage of time by the second, this process is calculated directly to show the actual quantity of blood flowing through the *vana femoralis* per minute. In making this experiment, care was taken so as to subject both sides to the same treatment as nearly as possible, and to prevent the fall of the temperature of the body, and allowance was also made for the effect of the operation on the blood-flow, the operation of extracting blood being thus usually made 30 minutes after the denudation.

NOTICE: *B.H.*=Bodily heat of the dog in the anus (↕) or in the vagina (♀)
R.T. =Room temperature.
R. =The right side.
L. =The left side.
Diff. =Difference between the right and left side.

29/XII. **EXP. XVI.** *59 days after the operation.*

No. 19 dog Wt. 7.26 Kgm.

(Ca. 2 cms. denudat. on the right side.)

			Blood-flow per min. c.c.		
Hrs. p.m.	*Mins.*	*B.H.* (*R.T.*)	*R.*	*L.*	*Diff.*
1	00	32°.5c (14°)	7.992.	7.968.	0.024. (R.+)
2	00	32°.5c (14°)	7.858.	7.931.	0.073. (L.+)

22/I 1924. **EXP. XVII.** *86 days after the operation.*

No. 24 dog ♀ Wt. 8.25 Kgm.

(ca. 7 cms. denudat. on the right side.)

Blood-flow per min. c.c.

Hrs.	*Mins.*	*B.H.* (*R.T.*)	*R.*	*L.*	*Diff.*
A.M.					
11	40	31°. (12°)	11.272.	11.250.	0.022. (R.+)
P.M.					
0	30	30°.5 (12°.5)	8.687.	9.048.	0.361. (L.+)
1	30	28° (12°)	6.750.	7.083.	0.333. (L.+)

1/V 1924. **EXP. XVIII.** *108 days aftar the operation.*

No. 25 dog ♀ Wt. 6.50 Kgm.

(ca. 4.5 cms. denudat. on the left side.)

Blood-flow per min. c c.

Hrs.	*Mins.*	*B.H.* (*R.T.*)	*R.*	*L.*	*Diff.*
A.M.					
12	00	.....	4.965.	5.101.	0.136. (L.+)
P.M.					
1	00	.....	5.333.	5.241.	0.092. (R.+)

9/V 1924. **EXP. XIX.** *118 days after the operation.*

No. 14 dog ♀ Wt. 8.00 Kgm.

(ca. 4 cms. denudat. on the right side.)

Blood-flow per min. c.c.

Hrs.	*Mins.*	*B.H.* (*R.T.*)	*R.*	*L.*	*Diff.*
P.M.					
5	00	30°. (12°.5)	2.262.	2.181.	0.081. (R.+)
5	30	29°. (12°.5)	2.285.	2.041.	0.244. (R.+)
5	45	28°.5(12°.5)	2.181.	2.090.	0.097. (R.+)
6	00	28°.5(12°.5)	2.448.	2.400.	0.048. (R.+)

9/V 1924. **EXP. XX.** *182 days after the operation.*

No. 7 dog ♀ Wt. 8.80 Kgm.

(ca. 2 cms. denudat. on the right side.)

Blood-flow per min. c.c.

Hrs.	*Mins.*	*B.H.* (*R.T.*)	*R.*	*L.*	*Diff.*
A.M.					
11	00	36°. (12°.5)	3.447.	3.238.	0.209. (R.+)
11	15	36°. (12°.5)	3.698.	4.000.	0.302. (L.+)
11	30	36°. (12°.5)	3.428.	3.867.	0.439. (L.+)

On surveying the results of the aforementioned five experiments (experiments XVI–XX), it is found that whereas in the case of Experiment XV (41 days after the operation) previously reported, there was a very slight increase of bloodflow compared to the opposite side, no difference in blood-flow was noticed (between the two sides) in the case of Experiment XVI (59 days after the operation) and that in the cases of Experiment XVII (86 days after the operation), Experiment XVIII (108 days after the operation), Experiment XIX (118 days after the operation) and Experiment XX (182 days after the operation) also there was no difference between the right and the left side in respect of blood-flow.

Daijo Kobayashi.

The following experiments were then tried with a view to ascertaining what change in blood-flow would be produced by Leriche's operation effected on both sides of one and the same animal but with a difference in the length of denudation involved:

11/I 1924. **EXP. XXI.** *Through one day.*
No. 20 dog ↕ Wt. 6.40 Kgm.

(Ca. 2 cms. denudat. on the left side at p.m. 30 mins.)
(Ca. 4 cms. denudat. on the right side at p.m. 50 mins.)

Blood-flow per min. c.c.

Hrs.	*Mins.*	*B.H.* (*R.T.*)	*R.*	*L.*	*Diff.*
		Before Periaterial sympathectomy.			
A.M. 11	40	36°.8(11°)	3.698.	3.512.	0.186. (R.)
P.M. 0	05	36°.8(11°)	3.600.	3.500.	0.100. (R.+)
		After Periarterial sympathectomy.			
P.M. 4	30	33° (12°)	2.639.	2.901.	0.262. (L.+)
5	00	33° (12°)	2.962.	3.226.	0.264. (L.+)
5	30	32° (12°)	3.681.	3.800.	0.119. (L.+)

16/VI. 1024. **EXP. XXII.** *21 days after the operation.*
No. 28 dog ↕ Wt. 7.25 Kgm.

(ca. 7 cms. on the right;
ca. 2 cms. on the left side denudat.)

Blood-flow per min. c.c.

Hrs.	*Mins.*	*B.H.* (*R.T.*)	*R.*	*L.*	*Diff.*
P.M. 0	30	38°.5(25°.5)	11.320.	9.375.	1.945. (R.+)
0	40	38°.5(25°.5)	10.909.	8.571.	2.338. (R.+)
0	52	38°.5(25°.5)	10.434.	8.275.	2.159. (R.+)
1	10	38°.5(25°.5)	10.000.	7.594.	2.406. (R.+)

On examining two foregoing cases (Experiments XXI and XXII), it will be found that in the case of Experiment XXI the rate of blood-flow before the operation was greater, though very slightly, on the right side than on the left, but it decreased on both sides up to $4\frac{1}{2}$ hours after the operation and then it began to increase, the increase being greater on the left side than on the right, the difference between both sides being very small 5 hours after the operation. It is to be supposed, however, that if my observation had been continued longer, the blood-flow on the right side would have been found to increase to a greater extent than, and ultimately to exceed, that on the left.

But this supposition could not be verified, as my observation was not kept up long enough.

In experiment XXII, denudation was made about 5 centimetres longer on the right side than on the left, the result being that the difference in blood-flow between the right and left sides amounted to nearly 2 ccs., as shown in the accompanying table. I believe that the proper conclusion to be drawn from this observation is that in order to obtain greater effect by Leriche's operation (periarterial sympathectomy) denudation should be effected over a greater length as suggested by Leriche, Brüning and their supporters, in which case the effect will also be of longer duration-an impression which is all the more strengthened when the result of this experiment is compared with the result of Experiment XIV in which Leriche's operation was made on one side only and the condition was examined 24 days after the operation.

Microscopic Examination.

Respecting Experiments other than Experiments *XVIII and XXI.*

Experiment XVI. *The right (side operated on).*

The fibres of the *lamina elastica interna* mostly presented the usual wave-like appearance, but they had the shape of straight lines in a few parts.

The media was close, with a little laceration of muscular fibres in a small part facing the *adventitia*. *Lamina elastica externa* existed all round the media but they were of varying thickness.

No change was, however, noticeable in the thin part facing the media. The connective-tissue-layer of the *adventitia* of various grades of pigmentation enclosed the whole circumference of the *lamina elastica externa*.

The left (opposite side).

The fibres of the *lamina elastica int.* presented the usual wave-like shape like the operated side. The media was close and nothing unusual was noticeable.

The connective-tissue-layer was well pigmented and in parts thicker than that on the operated side.

Experiment XVII. *The right (side operated on).*

The vein cavity was almost round in shape and empty inside. The *lamina elastica int.* were mostly wave-like in shape, but more or less straight in places. The media was generally close and in a small part of it the most external layer was exfoliated, which part was thinner than the rest. Its muscle-fibres and those of *lamina elast. ext.* existing around it were found to be disordered in direction. The *lamina elast. ext.* existed all around the media, with the exception of the exfoliated part, to which reference has just been made, but it was somewhat uneven in thickness. Further, on its outer layer, there was a greater increase in capillary bloodvessels than on the other side, and its periphery was rich in juvenile connective tissue cells. It was occasionally saturated with round cells.

The other side: (Omitted).

Experiment XIX. *Right (operated) side.*

The *lamina elast. ext.* generally presented a wave-like appearance peculiar to them, but in places they were arc-like in shape. There were also places where epithelium was lacking. The media was somewhat coarse in quality and also thinner than on the other side. The *lamina elast. ext.* was torn in places and varied in thickness. But it existed almost all round the media, of which the part corresponding to the torn or thin part of the *lamina elast. ext.* was generally thinner than the rest.

Left (non-operated) side: Omitted because of there being no noteworthy change:

Experiment XX. *Right (operated) side.*

The vein cavity was almost elliptical in shape, while blood-corpuscles existed inside in the shape of lumps.

The *lamina elast. ext.* generally presented a wave-like appearance that is peculiar to them, but in one part they were considerably disfigured and rather arc-like than otherwise, the media corresponding to this latter part being about half as thin as the media for the other part.

The *lamina elast. ext.* on this side was, on the whole, thinner than that on the other side and it was also of

varied thickness. Of its part near the external side, the tissues were in places disordered in direction and penetrated into the outer layer, that is, the connective-tissue layer. The layer on this side was generally richer in cells and more deficient in blood vessels than on the other side, while the connective-tissue fibres ran in the shape of rings almost parallel to each other.

And the original *adventitia* presented, at first sight, the appearance of a connective-tissue layer, but it considerably differed from the same on the opposite side.

In other words, the elastic fibres or fibres of nonstraited muscle were not distinctly noticeable.

In short, it is evident that this layer was a new connective-tissue layer that had grown into existence after the operation.

Left (non-operated) side. (omitted because of there being no remarkable change.)

Experiment XXII. *Right side.* (7 centimeters denudation.)

The vein cavity was round in shape with a few blood-corpuscles sticking to the inside thereof. The *lamina elast. int.* were almost of the shape of straight lines. There was hardly anything abnormal about the media. The *lamina elast. ext.* forming its outer layer was sparsely scattered on the side facing the media and it was generally of varied and uneven thickness. In places, it was dislocated from its proper position, and many (of its fibres) existed in disordered directions in its outer layer of the media, that is, the connective-tissue layer, in which considerable change was noticed on this side when contrasted with the other side. Thus, the capillary blood-vessels were expanded and congested, and around them were congregated juvenile connective tissue cells and a small number of round cells. There was bleeding in places, and some red blood-corpuscles were already collapsed and turned into haemoglobin and absorbed by the phagocytes and the cells of the endothelium of the bloodvessels. The other part of the layer was observed to be comparatively rich in connective-tissue cells, and the layer was fairly thick. (In reference see Drawing 1.)

The other side: (Omitted.)

Extra Experiment. (*Operated*) *side. 223rd day.*

The elastic fibres in the adventitia on this side were considerably fewer than on the other side, and sparsely existed near the media. On the other hand, the connective-tissue-layer on this side, of which the fibres run in circles and in parallel, is considerably thicker than that on the other side. Morever, the layer on this side is sparse, while that on the other is close. The infiltration of round cells and the congestion of the blood-vessels could no longer be noticed. (In reference see Drawing 2.)

The other side: Of this a drawing only is given (see Drawing 3.)

P.S.—Mr. B.G. Egoros of Moscow (1924) recently published the view that consequent on Leriche's operation the muscle tissue of the media vanishes and gives place to connective tissue, with the result that the blood-vessels become connective tissue vessels. But this statement is not borne out by the result of my experiments. It will be seen from the foregoing microscopic specimens that on the lapse of a certain time after denudation, very slight inflammation is produced around the vein which is then converted into connective-tissue, and that no increase is noticed in the elastic fibres in the denuded adventitia (see Drawing 1.) Morever, when very many days have elapsed (after the operation), the inflammation vanishes altogether and the part involved gets surrounded entirely with connective-tissues running in parallel in a circular form round the vein (see Drawing 2 extra.)

Three Clinical Cases.

All these cases were diagnosed by Prof. Dr. Hiromu Ito as *gangraena spontanea*. I will here content myself with stating only the main symptoms of the patients and the nature of the operation and the progress after the operation.

Case No. 1. *R. Inoue. Male. Aged 46 years. Kyōto. Admitted to hospital on February 1st, 1924.*

Previous illness: *Bubo inguinalis* at 17. Medium drinker and smoker. The patient suffered from ***Myelitis*** *dorsalis*

with *Scoliosis dorsalis dextra*. History of present Illness:

In February, 1918, apparently without any proximate cause, he felt a violent pain on the instep of his left foot, which pain radiated to the toes and made it impossible for him to sleep. In consequence, he had to have the big toe amputated in April, but the pain only increased in degree and red swelling was produced and extended up to the knee. He had Ringer's solution hypodermically injected about 120 times but these injections produced no effect whatever except that an ulcer was left behind. About May in the following year, the pain and ulcer gradually vanished and the man was able to resume work. About October 1921, however, he began to feel drawing pain in the calf of his left leg when walking-a condition in which he continued for a long time. About the beginning of 1923 it became impossible for him even to limp and he began to have sensory disturbance in his left leg. About June of the same year, ulcers were produced on the second and fifth toes and gradually spread until the toes affected had to be amputated in July.

Examination of Local Condition. In the left leg, *arteria femoralis* (+), *arteria poplitea* (+), *arteria dorsalis pedis* (—). A remarkable change was noticeable from the ankle-joint downwards, that is, the 1st, 2nd and 5th toes were gone, and in their place was seen dried-up skin like that of a mummy.

Irregularly round ulcers were seen in the region of the *metatarso-phalangeal* joint of the big toe, and just in the middle of the ulcers there was seen the *extensor hallucis longus* tendon.

These ulcers were filled with anaemic granulation and a small quantity of foetid secretion. They were a little livid in colour all round and a dilation of veins was noticed in the upper part thereof. In the upper part of the side of the 4th toe and in the region of the proximal phalanx of the 5th toe, the surface of small rectangular granulation was observed, it being parallel to the major axis of the toes, and its margin being partly undermined and showing a small quantity of secretion. Moszkowicz's test was taken with the following result: Left, 107 sec; right 11 sec.. The dimensions of the ulcers before the operation were: The bigger one, about 8.5 cms. in circumference, and the

smaller one, 2.7×6.5 cms.. Wassemann's reaction was negative. *Operation.* On the 13th February, after lumbar anaesthesia having been administered, the *arteria femoralis* on the left side was denudated to the length of about 7 cms. Before the denudation the artery was slightly pulsating and its diameter measured about 3 mms..

But soon after the operation its diameter increased to 5 mms. and the pulsation of the arterial branches also became remarkably active.

Progress after the Operation. On the 3rd day from the day of the operation the *arteria poplitea, tibialis posterior* and *dorsalis pedis* showed no pulsation. On the 4th day the circumference of the bigger ulcer measured 6.5 cms.

On the 7th day, no proliferation of *epithelium* was noticed anywhere. On the 10th day the bigger ulcer measured 6.1 cms. and 6.2 cms. on the 12th day and 6.4 cms. on the 15th day, but there was no proliferation of *epithelium* anywhere.

The same ulcer measured 6.2 cms. on the 19th day, and also on the 23rd day, 6.0 cms. on the 31st day, and 6.2 cms. on the 43rd day. No new skin was formed in any part of the ulcer and on the 48th day intense gluteal pain was experienced. In short, no tendency to cure was observable anywhere. And owing to another complaint (*myelitis dorsalis*) from which the patient was suffering at the same time, I was unable to determine what was exactly the pain that was caused by the ulcer.

Case No. 2. *E. Kimura. Male. Aged 30 years. Kyōto. Admitted to hospital on March 11th, 1924.*

Previous Illness: Nothing worthy of special mention.

History of present Illness: In November, 1923, the patient got on the tip of the big toe of his left foot a chilblain which soon developed to an ulcer and the part underneath the nail became whitish with moisture, but there was neither pain nor *oedema.*

The ulcer gradually grew bigger in size and discharged a small quantity of pus mixed with blood.

About a month later, spontaneous pain was experienced on the spot of the ulcer and despite all sorts of medical

treatment received to combat the trouble, the symptoms grew from bad to worse as time went on, the chief complaint of the patient being the pain which he experienced and which was so intense that it prevented him from sleeping at night. *Examination of Local Conditions.*

Left big toe (as viewed from the inside).

Size of ulcer : 6.5 cms. in circumference.

Anaemic granulation.

Good granulation.

Nail with partial defect.

On pressing the point marked "X", there would arise a violent pain which transmitted itself up to the knee, while fetid thin pus oozed out of it. The dorsum of the foot down to the toes were slightly cyanotic.

Patellar and achillis jerks were strong. The pulsation of the *arteria poplitea*, *tibialis posterior* and *dorsalis pedis* was imperceptible on the left side, while on the right side the *arteria femoralis* and *poplitea* alone pulsated. The *hyperaemia* (Moszkowicz's) test repeated three times before the operation showed the following result :

	March 13th	*March 15th*	*March 18th*
Left side	1 min. 46 secs.	1 min. 40 secs.	1 min. 40 secs.
Right side	21 secs.	21 secs.	21 secs.

On March 17th, the size of the ulcer measured 6.5 cms. as before. Wassermann's test showed no reaction. *Operation.* On March 19th, the operation was effected on the patient under lumbar anesthesia in accordance with Leriche's method, the *arteria femoralis* being denuded to the length of about 7.5 cms.. In the course of the denudation the pulsation of the *arteria femoralis* was observed to get stronger.

Progress after the operation : On the morning of the following day (March 20th), the *arteria poplitea* pulsated, and the dorsum of the foot was reddish and warm, but spontaneous pain was occasionally experienced in the same

manner as before. On the 3rd day the pain abated, the patient having slept soundly during the previous night for the first time since he had contracted the disease. The ulcer was almost dry and its width measured 5.6 cms. On the 6th day, the local pain was further abated and there was a slight sensation of itching, the width of the ulcer standing at 5.7 cms. On the 7th day, the pain on the spot showed a slight increase and there was a perceptible pulpitation of the *arteria poplitea*.

There was a further increase in the pain on the 9th day.

On the 11th day there was a slight abatement in the spontaneous pain and pain produced by pressure, but the colour of the dorsum of the foot was still cyanotic, though in a lesser degree than before.

As for the size of the ulcer, it measured 5.8 cms.. The patient left hospital on the same day. When he was examined on the 28th day, he remarked that he was now able to walk with ease, but the ulcer had not got much smaller. The arteria poplitea pulsated though to a smaller extent than that on the right side. The result of Moszkowicz's test was 75 secs. On the 34th day the patient felt the same as before, but the ulcer had become smaller, and the spontaneous pain on the outer side of the big toe vanished.

The *arteria poplitea* pulsated and there was a slight secretion. When seen on the 41st day, about two-thirds of the ulcer (mostly the part of the good granulation) was covered with epithelium, but the ulcer still penetrated underneath the nail. Moszkowicz's test: 78 secs. On the 65th day the *arteria poplitea* still pulsated but the ulcer had become smaller and produced no secretion, but pain was still felt when pressed. On the 136th day, the patient said that since one week before he had occasionally experienced tingling pain in the region from the tip of the big toe to the knee after walking a distance of about 100 metres. Objectively, the ulcer was almost covered with cuticula, but pressure still produced pain, though in an extremely slight degree. Moszkowicz's test: 105 secs.. On the 157th day the ulcer was found covered entirely with cuticula and no pain was felt on whatever spot it might be pressed.

The patient was now able to walk a distance of 5 miles or so without difficulty. Moszkowicz's test: 80 secs. (the right side, 23 secs.). But the pulsation of the *arteria poplitea*, *tibialis posterior* and *dorsalis pedis* was imperceptible.

Case No. 3. *T. Fujita, Male. Aged 34. Kōbe. Admitted to hospital on May 5th, 1924.*

Previous Illness Nothing worthy of special mention

History of Present Illness: In January, 1914, the man experienced a sensation of itching on the 5th toe of his right foot and soon after an ulcer was formed without any preliminary symptoms whatever, and violent pain was caused when pressure was put on the toe, which, moreover, getting mummified, had to be amputated.

From that time onwards he increasingly felt as if he could not put force in the sole of the foot when walking though he felt semewhat better after a rest. He also sometimes felt a chill at the tip of the foot. When he was 30 years old, he experienced a sensation of itching and also spontaneous pain underneath the nail of the big toe of the left leg, which toe gradually swelled into an ulcer. But he was cured of the ulcer in the course of about 60 days after the falling off of two pieces of bone as a result of surgical treatment.

In December, 1923, however, the same symptom appeared again, but on the big toe of the right foot this time, the formation of an ulcer being followed by the mummification of the part affected. The main complaints of the patient were the foetid ulcer and the violent pain which accompanied it.

Examination of Local Condition: The right foot was phlegmonously swelled, this being particularly the case with the dorsum. The 5th toe was missing, while the big toe was in a black and mummified state and felt cold, it being partly ulcerated and secreting fetid pus. Wassermann's blood test produced no reaction.

Operation: On May 9th, after lumbar anaesthesia having been administered, the right *arteria femoralis* was denudated to the length of about 8 cms.. In the course of the denudation the artery contracted to about two-thirds of its former diameter, which was about 5 mms.

Arterial pulsation of both lower extremities. Hyperaemia-test (Moszkowicz's)

Before the operation.

		Arteria femoralis.	*Poplitea.*	*Tibialis posterior.*	*Dors. Pedis.*
May 5th	Left side	++	+	—	82 secs.
	Right side	++	—	—	220 secs.

On May 6th, the pain in the foot was so intense that the patient was unable to sleep all the night.

After the operation: On the 2nd day from the operation, the spontaneous pain abated, so that the patient was able to sleep soundly for the first time since he had fallen ill. (Before the operation he had always been awakened by sharp pain from time to time.) The pulsation of the *arteria poplitea* was perceptible. On the 3rd day also, the same was perceptible. On the 4th day there was an abatement in the spontaneous pain, while on the 5th day the phlegmonous swelling of the foot lessened, though spontaneous pain was occasionally experienced.

Arterial pulsation of both lower extremities after the operation.

		A. femoralis.	*Poplitea.*	*Tibialis Posterior.*	*Dorsalis pedis*
8th day	Left side	++	+	—	—
	Right side	++	+		+

The demarcation lines of the big toe became distinctly noticeable.

11th day	Left side	++	+	—	—
	Right side	++	+	+	+

On this day the spontaneous pain further abated, while on the 13th day the redness and ulcer enlarged a little.

14th day	Left side	++	+	—	—
	Right side	++	+	+	+

The result of hyperaemia test taken this day was: Left side, 1 min. 30 secs. and right side, 1 min. 28 secs.. On the 6th day the necrotic big toe went off. On the 18th day the pulsation of the *arteria femoralis* of the operated side

became fainter and that of the *arteria poplitea* barely perceptible, whereas the pulsation of the *tibialis posterior* and *dorsalis pedis* was imperceptible, as tabulated below:

18th day	Left side	++	+	—	—
	Right side	+	Barely +	—	—

On the 19th day there was a slight abatement in the spontaneous pain. On the 20th day, the pulsation of the *arteria femoralis* on the right side was perceptible as before, but that of the *arteria poplitea* and *tibialis posterior* was faint, while that of the *dorsalis pedis* was imperceptible. The result of hyperaemia test taken this day was: Right side. 1 min. 30 secs.

On the 23rd day, the spontaneous pain increased a littie, as also did the phlegmonous swelling, especially on the dorsum of the foot. As for the state of arterial pulsation, it was perceptible in the case of the *arteria femoralis* only and not perceptible in the case of all the rest.

On the 28th day, the 2nd toe became almost necrotic and a fresh ulcer was formed on the inside of the third toe. On the 29th day, hyperaemia test showed 2 mins. 1 secs. on the right side. On the 32nd day the 2nd toe fell off, a great deal of secretion being noticed. On the 34th day the pulsation of the *arteria femoralis* became extremely faint and the 3rd toe was almost gangraenous. On the 49th day the pulsation of the *arteria poplitea* was barely perceptible, hyperaemia test showing 2 mins. 25 secs..

The necrotic bone at the root of the big toe and the 3rd toe dropped this day. Attacks of spontaneous pain decreased and the patient was able to sleep. On the 53rd day, the pulsation of the *arteria femoralis* only was perceptible while that of the *arteria poplitea* and the rest was entirely imperceptible. Hyperaemia test showed 3 mins. 75 secs.. There was a small quantity of secretion.

On the 73rd day the condition of arterial pulsation was the same as before, while hyperaemia test showed 3 mins.

25 secs.. On the 91st day, thc local symptoms appeared aggravated rather than otherwise, The redness of the dorsum was intensified, the 4th toe became necrotic, the slightest touch producing most violent pain, and the inside of this toe showed 2 tendons which had also become necrotic. In the internal upper part of the big ulcer there was comparatively good granulation, but the lower part on its sides was full of anaemic granulation and produced a quantity of foetid secretion. But the violent spontaneous pain–the patient's main complaint–had considerably abated since the operation. It existed only to a very slight extent and the patient was therefore now able to sleep soundly.

In summing up the experience gained in the three foregoing cases, I want to discuss their clinical value from three foregoing cases, I want to discuss their clinical value from three points of view, namely, (1) pain, (2) hyperaemia (Moszkowicz's) test and (3) ulceration, always comparing the condition before and after the operation.

In the first case, the effect of the operation lasted only 9 days so far as the ulcers were concerned, the condition being found worse rather than better 42 days after the operation. In the second case, the *arteria poplitea* already pulsated on the morning following the operation and there was also an abatement in spontaneous pain. Though pulsation was perceived even at the end of 64 days after the operation, it was much abated in strength, being somewhat weaker than what was noticed on the 34th day from the operation. On the 157th day no pulsation of the *arteria poplitea* was perceived, although hyperaemia test showed that the speed was as much as 20 secs. greater than it had been before the operation. As for the ulcer, it was distinctly cured. In the third case, the patient was able to sleep well already on the very night following the operation; the *arteria poplitea* pulsated, while a decrease in the phlegmonous swelling was observed on the 5th day. On the 11th day, the pulsation of the *arteria poplitea*, *tibialis posterior* and *dorsalis pedis* was perceptible and a further decrease in the pain was observed. On the 18th day, however, the pulsation of the *arteria femoralis* and *arteria poplitea* on the operated side was weakened, while the *tibialis posterior* and *dorsalis pedis* ceased to pulsate.

Hyperaemia test showed that after the operation there was at first an increase in the speed, which, however,

gradually slowed down until on the 73rd day it was 3 mins. 40 secs., that is, about the same as before the operation.

It will be gathered from these examples that Leriche's operation begins to take effect from 5 to 6 hours after the operation, the greatest effect being reached one week or so thereafter, from which time onwards its effect gradually weakens.

In the second instance above quoted, despite that the state of arterial pulsation and the result of hyperaemia test grew worse, the ulcer was cured. I think that this latter result is to be ascribed to the effect of the operation (hyperaemia), though small, rest, and the disinfectant treatment of the ulcer.

What is then the real effect of periarterial sympathectomy in the light of my experiments and the clinical cases which have come under my observation?

As for the result of my experiments on animals, there was a decrease in blood-flow (anaemia) for a short while in the part under the control of the denuded artery, but from 4 hours 30 minutes or 6 hours 20 minutes after the operation onwards there was, in all cases, an increase in blood-flow (hyperaemia) as already pointed out in the concluding part of my first report. But the hyperaemia in question was observed only for a short time after the operation, it being hardly perceptible 41 days after the operation, while 59 days after the operation nothing abnormal was noted in blood-flow.

In Experiment XXII, in which denudation was effected on one side 5 cms. longer than on the other side, a pretty great hyperaemia was observed even after the lapse of 21 days after the operation, but it is quite certain that this effect (of the denudation) would have disappeared in the course of a longer time–a conclusion which is confirmed by the result of microscopic observation as narrated above.

My clinical investigations also show that the effect of Leriche's operation is at its height about one week after the operation, subsequent to which the condition gradually grows worse. It is believed that the cicatrisation due to the operation is one of the many contributory causes for bringing about the untoward tendency which was noted to recur

in the experiments and clinical cases under survey.

But what is the cause of the hyperaemia that is temporarily noticed after the operation?

Taking as a basis the conclusion reached as a result of the investigations by Potts, Kramer, etc. (that the sympathetic nerve fibres reach the wall of the operated artery at intervals), in explaining the expansion, although temporary, of the vessels under the control of that part of the artery in which Leriche's operation has been effected (in my own experiments the part affected only was noticed to expand), I am of the same opinion as Langley who says: "The effect must, I think, be due to some other cause than section of nerve fibres running to periphery in the arterial sheath." On the other hand, Leriche and Brüning remark that by this operation the course of transmission of stimulating reflection is cut off, while Langley supposes that "possibly it (the effect) may be due to section of afferent fibres, or to the contracted part of the artery being near the point of periarterial section." In short, there is no definitely established theory on this point. Morever, I regret I am not in a position to explain why spontaneous pain is felt less after the operation than before, in my clinical cases, even when the other symptoms assume adverse tendencies.

Conclusions.

1. The increase in blood-flow in the hind limb after Leriche's operation is not permanent.

4 hours 30 minutes to 6 hours 20 minutes after periarterial sympathectomy, an increase in blood-flow was observed to begin, and the rate of increase gradually increasing from that time on, a remarkable hyperaemia was noticed during the interval from 16 hours to 4 days after the operation, but a tendency to anaemia was already observed 8 days after the operation and the decrease in blood-flow gradually going on, the extent of increment in blood-flow (Hyperaemia) was extremely small 41 days after the operation (as already stated in my first report). The original condition was restored 59 days after the operation and no difference in respect of blood-flow was noticed between the operated and

the other side 86 days, 108 days, 118 days and 182 days after the operation. (see Experiments XVI, XVII, XVIII, XIX and XX.)

2. But in case the artery is operated on to a greater length, the increase in blood-flow is of much longer duration than when the operation is of a shorter length. In regard to the difference of blood-flow between the right and left sides, EXP. XXII and EXP. 10 (in my first report) amounted almost equally to nearly 2 ccs., but in the former case denudation was made about 5 cms. longer on the opposite side and was examined 21 days after the operation, but in the latter, about 2 cms. was done and examined only 3 days after the operation.

3. According to the result of histological investigation, after the denudation of the artery the *lamina elastica externa* (on the operated side) becomes in some cases thinner than that on the other side, but the *lamina elastica interna* preserve the usual wave-like appearance and no alteration is observed in the media either (see Experiment XVI.).

In other cases, however, the regeneration of adventitia is not observed on the *lamina elastica externa,* and the post-operative cicatrisation takes the place of the adventitia denuded off. (see Experiments XXII and Extra Experiment.)

The conclusion to be drawn from the above is, I think, that in case adventitia is denuded by Leriche's operation, there is an increase for a short time in blood-flow under its control, but the increase in blood-flow is checked again as a result of the cicatrization which soon takes place.

Explanation of the plates.

(1). Picture of the right *art. femoralis* of the EXP. XXII (21 days after the operation).

(b) is hyperaemia layer in the connective tissue-layer, where are a lot of capillaries' dilatation and infiltration of round cells around them.

(c) is the elastic fibres' layer of the Adventitia, which is exfoliated here and there.

(2). Picture of the left *art. femoralis* (223 days after the operation).

(a) is the connective tissue-layer, where we cannot see hyperaemia as that of (1).

(c) is the elastic fibres' layer of the Adventitia.

(3). Picture of the right *art. femoralis* (opposite side of the (2) specimen).

(a) is the connective tissue-layer.

(c) is the elastic fibres' layer.

Effect on Blood-flow after the section of *the Abdominal Sympathetic Trunk*.

Before discussing the results of my experiments bearing on this question. I will relate a brief description, announced announced by many investigators, of the anatomy of the communication of the sympathetic nerves to the hind limb of animals.

The sympathetic nerve in the spinal cord exists as *nucleus sympathicus lateralis superior* extending from the 8th cervical segment to the 3rd lumbar segment and the vasoconstrictors emerging therefrom control the face, the upper and lower limbs and the trunk (L. R, Müller). Further, the vasomotor fibres to the hind limb start from the six ventral roots from the 11th dorsal to the 3rd lumbar (W. M. Bayliss and J. R. Bradford), and after combining with the nerve fibres derived from the dorsal root of the spinal cord (after those latter nerve fibres have passed through the spinal ganglia), they enter the abdominal sympathetic ganglia as *Rami communicantes albi* (Gaskell, Müller).

The centrifugal fibres to the hind limb start either from the 6th lumbar to the 2nd sacral (Langley) or from the 4th lumbar to the 1st sacral nerve (Werzihoff), and after receiving the fibres of the *Rami communicantes gresei*, combine with the spinal nerves, this is, *plexus lumbosacralis*, and go to the hind limb (Ostroumoff, Gaskell, Gaertner, P. Halsterlik and A. Biedl, Bayliss and Bradford, Werzihoff, Müller).

The sympathetic nerve fibres to the hind limb, after combining with the spinal nerve fibres, touch the main vessels at various points as they go.

As a rule, special nerves do not go into the small vessels which are branch currents from the bigger vessels, for they usually obtain nerve plexus direct from the sympathetic plexus situated on the top of the so-called "parent" artery (Potts), whereas only nerve bundles exist in the adventitia of vessels (Müller and Glässer).

To sum up the foregoing results of researches made by various investigators, the sympathetic nerve fibres to the vessels in the foot start from the *Rami communicantes gresei* of the 4th lumbar to the 2nd sacral sympathetic and descend downwards together with the spinal nerves. On the other hand, the vasodilator fibres start from the dorsal root of the spinal cord, and, after passing through the spinal ganglia, they unite with the spinal nerves and go straightway to the periphery, and there is no communication whatever between them and the sympathetic trunk (Gaertner; P. Hasterlik and A. Biedl; Bayliss; Müller). But by Langley both the preganglionic fibres causing pallor and those causing flushing were found to end in the same sympathetic ganglia. He regarded the results as evidence of the existence of vasodilator fibres in sympathetic nerves.

Principal Pieces of Literature bearing on my Experiments.

A. Stroumoff (1876) cut the abdominal sympathetic trunk, in consequence of which he observed that the temperature of the hind limb showed a rise which lasted about 20 days.

W.H. Gaskell (1878-9) observed, on cutting the abdominal sympathetic trunk of a dog, that the arteries in the muscles of its foot got dilated as a result, that the dilatation reached a maximum about 20 to 40 secs. after the cutting, and that the arteries were restored to the condition before the cutting at the end of 2 to 4 minutes after the cutting—a fact which he ascertained by directly inserting a pipette into the vessels. In announcing this result of his experiments, he advanced the hypothesis that the phenomenon was perhaps due to the strong expiratory action of the abdominal muscles caused by the cutting.

S. Lewaschew (1882) observed that the influence of the vasomotor apparatus was strongest at the tip of the foot

and grew weaker upwards to the kneecap and the thigh. Werzihoff (1896) remarked that on the abdominal sympathetic being cut, the temperature of the hind limb had risen by 5° to 7°C. and that the colour of the blood flowing through the veins during the time had looked brighter than usual.

Bayliss (1902) announced that he had observed a vasodilator reflex occuring on the hind limb in consequence of cutting the abdominal sympathetic.

In making experiments on the basis of the anatomical and physiological information above quoted, I cut the abdominal sympathetic between two ganglia, isolated the preganglionic fibres from the hind limb, and measured the rate of blood-flow therein, comparing the result with the rate of blood-flow on the side opposite to the operated side and finally comparing the result of the operation with that produced by periarterial sympathectomy.

Experiments.

Method of experiment.

Experiments were made on dogs, urethane being used as anesthetica, as in the case of periarterial sympathectomy.

But in the case of those to be experimented on after the lapse of a certain period (after preliminary operation) 4 percent morphinum hydrochloricum was hypodermically injected at the time of the preliminary operation, the quantity varying between 4 and 10 ccs. according to the weight of the animals concerned, in the same way as in the case of periarterial sympathectomy.

Preliminary Operation:

Shaving hair off the abdominal wall and disinfecting the spot as usual, the skin was cut open 10-13 cms. around the navel along the median line.

Laparotomy was next effected and the abdominal organs being pushed aside to the upper part and the right side or (when the sympathetic trunk on the right side was cut) to the left side of the peritoneal cavity, the peritoneum

parietalis was torn as under either on the left side of the *aorta abdominalis* or on the right side of the *vena abdominalis*. The opening of the incision being enlarged upwards and downwards the *aorta abdominalis* was pushed aside to the right side or the *vena abdominalis* to the left side (as the case may be) carefully with the fingers of the left hand, when the abdominal (sympathetic) trunk would be easily found either below the aorta (or vena) and extending between the *vasa renalis* and the branching point of the *vasa abdominalis*. The sympathetic trunk was then cut with a small half-moon shaped knife at the desired point between two ganglia. In this connection it would be somewhat difficult to expose to sight the interstitial space between the 4th and 5th ganglia, as it is usually underneath the *vasa renalis*, but the thing would be accomplished without much difficulty if the *vasa renalis* should be pulled upwards or downwards a little.

Before cutting the sympathetic trunk on one side, the sympathetic trunk on the other side (the non-operated side) was exposed in the same manner and at the same point as the operated side; and the sympathetic trunk on the operated side was then cut. This was done in order to make the effect of the exposure of the sympathetic trunk on the blood-flow in the hind limb equal on both sides.

On the sympathetic trunk being cut, the opening (incision) in the abdomen was immediately sewn up twofold (in case experiment was to be made on the same day as the operation, the opening was merely cramped).

The rate of blood-flow in both feet was then measured by inserting a pipette directly into the *vena femoralis*, everything in this connection being done in the same manner and with the same care as in the case of periarterial sympathectomy.

The rate of blood-flow per minute was calculated by means of a kymograph or stop-watch.

P.S. 1. In case preliminary operation and experiment were made on the same day, the operation for exposing the *vena femoralis* was effected first and then the sympathectomy. In any other case, the former operation only was made on the first day.

2. In either case, laparotomy was effected again upon the completion of the experiment, in order to ascertain where the sympathetic trunk had been cut.

Experiments.

Experiments No. 1a, 1b, 1c, 1d, 1e, and 1f were made on the same day as the preliminary operation, their object consisting in comparing the rates of blood-flow before and after the cutting of the sympathetic trunk and also comparing the blood flow on the operated side with that on the other side. The results of these experiments are tabulated as follows :—

23/VI 24. **EXP. I.** *Sympathectomy.*

No. 1b dog ↕ Wt. 5.70 Kgm.

Blood flow per min cc. Past hours aft. op.

Hrs.	*Mins.*	*B.H. (R.T.)*	*R.*	*L.*	*Diff.*	*Mins*
A.m. 11	30	Before the operation				
			6.250.	5.769.	0.481. (R.+)	—
P.M. 0	7	Laparotomy and the region of the *5th and 6th* ganglia is free on both sides.				
0	10	38°.c(26°.c)	5.217.	4.908.	0.309. (R.+)	—
0	20	38°.c(26°)	5.128.	4.705.	0.423. (R.+)	—
0	28	Sympathectomy between the *5th and 6th* ganglia on the *left side.*				
0	30	38°(26°)	4.347.	9.090.	4.743. (L.+)	0.2
0	40	38°(26°)	4.761.	5.217.	0.456.	12
0	45	38°(26°)	3.973.	4.958.	0.985.	17.
0	50	38°(26°)	3.571.	4.316.	0.745.	22.

28/VI 24. **EXP. I.** *Sympathectomy.*

No. 1b dog ↕ Wt. 6.50 Kgm.

Blood-flow per min. cc. Past hours aft. op.

Hrs.	*Mins.*	*B.H (R.T.)*	*R.*	*L.*	*Diff.*	*Mins.*	*Secs.*
A.M. 10	10	37°.5c(27°c)	4.800.	4.496.	0.304 (R.+)	Before the	
10	20	37°.5(27°)	6.295.	6.000.	0.295 (R.+)	Operation.	
10	40	Laparotomy, the region of the *4th and 5th* ganglia is only free on both sides.					
10	45	36°.5(27°)	3.428.	3.234.	0.194. (R.+)	—	
10	57	36°.5(27°)	3.555.	3.096.	0.459. (R.+)	—	
11	05.55 secs.	Sympathectomy betw. the *4th and 5th* ganglia on the *left* side.					
11	06.30 secs.	—		13.333.	—	0	35
11	07	36°.5(27°)	3.234.	12.387.	9.153. (L.+)	1	35
11	30	36°.5(27°)	3.840.	7.600.	3.760.	24	35
11	40	36°.5(27°)	2.258.	6.000.	3.742.	34	35
11	50	36°.5(27°)	2.380.	4.860.	2.480.	44	35
12	00	36°.5(27°)	2.400.	4.800.	2.400.	54	35.

12/VI 24. **EXP. I.** *Sympathectomy.*

No. 1c dog ↕ Wt. 7.20 Kgm.

Blood flow per min. c.c. Past hours aft. oper.

Hrs.	*Mins.*	*B.H. (R.T.)*	*R.*	*L.*	*Diff.*	*Mins.*
Before the operation			7.500.	7.500.	0	—
			7.317.	7.594.	0.277. (L.+)	—
P.M.						
0	10	Laparotomy, the region of the *5th, 6th and 7th* gang. is only free on both sides.				
0	30	38°.c(25°)	5.217.	5.217.	0	—
0	38	Sympathectomy betw. the *6th and 7th gang.* on the *left* side.				
0	40	38°.c(25°)	4.800.	9.836.	5.036.	2.
0	50	38°(25°)	5.217.	9.600.	4.383.	12.
1	00	38°(25°)	6.250.	8.333.	2.083.	22.
1	20	38°(25°)	5.714.	7.500.	1.786.	42.
1	40	38°(25°)	5.000.	6.666.	1.666.	62.

25/VI 24. **EXP. I.** *Sympathectomy.*

No. 1d dog ↕ Wt. 11.00 Kgm.

Blood flow per min. c.c. Past hours aft. oper.

Hrs.	*Mins.*	*B.H. (R.T.)*	*R.*	*L.*	*Diff.*	*Mins.*
A.M.						
12	00	36°.5c(25°)	8.219.	8.163.	0.056 (R.+)	Before the operation.
P.M.						
0	30	Loparotomy the region of the *5th and 6th* gang. is only free on both sides.				
1	10	37°.c(26°)	10.000.	10.000.	0	—
1	17	Sympathectomy betw. the *5th and 6th gang.* on the *left* side.				
1	20	37°(26°)	8.450.	12.000.	3.550.	3
1	30	37°(26°)	7.058.	10.344.	3.286.	13
1	40	37°(26°)	6.521.	9.375.	2.854.	23
2	00	37°(26°)	5.000.	8.888.	3.888.	43
2	10	37°(26°)	4.800.	8.888.	4.088.	53

To sum up the results of the above four experiments. As already stated in my first report, the difference between both sides in respect of blood-flow in normal conditions was always 0.55 cc. or less.

Even after the sympathetic trunk had been exposed by means of laparotomy, the difference was still about the same. In all the cases of the above experiments (except Experiment 1d) blood-flow showed a decrease of about 2ccs. on both sides after the laparotomy; and also in the case of Experiment IVB (to be described later on), where the abdomen was reopened a number of days after the cutting of the sympathetic trunk, the blood-flow on both sides showed a decrease of about 1cc. or more.

In my opinion, this decrease in blood-flow is to be ascribed to the exposure of the peritoneal cavity to the outer

air. In the case of Experiment 1d, I stirred the part surrounding the exposed part to a greater extent than in the other cases and there by stimulated the spinal nerves existing in the same region. It was probably owing to the effect of this stimulation on the vasodilator that the particular experiment showed a different result from other experiment.

After sympathectomy, the blood-flow on the operated side was found to increase to a remarkable extent, as shown in the foregoing tables. But in the above experiments (except Experiment 1c) and in Experiment 1f, the result of which is given in one of the following tables, this increase in blood-flow occurred only 35 seconds to 3 minutes after the operation, while a considerable abatement in blood-flow was already observed 8 minutes after the operation.

The rate of blood-flow was always greater on the operated side than on the other side, and the colour of the blood in the veins was also brighter on the operated side than on the other.

The hypothesis advanced by Gaskell that the increase in blood-flow directly after the operation is due simply to the strong expiratory action of the abdominal muscles seems to me not entirely satisfactory.

The fact that the operation is followed by an increase in blood-flow which reaches a maximum about 35 seconds after the operation but that there is a considerable decrease in blood-flow from about 3 minutes after the operation onwards may be experimentally accounted for by such a hypothesis as his. But it does not explain why the rate of blood-flow is still greater on the operated side than on the other 62 minutes after the operation (see Experiment No. 1c).

3/V 24. **EXP. I.** *Sympathectomy.*

No. 1e dog ♀ Wt. 6.80 Kgm.

Hrs. A.M.	*Mins.*	*B.H.* (*R.T.*)	*Blood-flow per min. C.C.* *R.*	*L.*	*Diff.*	*Past hrs. aft. oper.* *Hrs.*	*Mins.*
10	00	Laparotomy the region of the *5th and 6th* ganglia is free on both sides. then cut betw. above 2 gang. on the *left* side.					
11 P.M.	30	35°.5c(12°.5)	2.604.	4.363.	1.759.	1	30
1	00	34°.5(13°)	2.400.	4.363.	1.963.	3	00
2	00	33°.5(13°)	1.960.	3.490.	1.530.	4	00
2	30	33° (13°)	2.024.	4.444.	2.420.	4	30
3	30	32° (13°)	2.864.	3.753.	0.889.	5	30
4	00	31°.5(13°)	1.157.	1.707.	0.550.	6	00

24/VI 24. **EXP. I.** *Sympathectomy.*

No. 1f dog ♀ Wt. 9.78 Kgm.

Hrs. P.M.	*Mins.*	*B.H.* (*R.T.*)	*Blood-flow per min. C.C.* *R.*	*L.*	*Diff.*	*Past hrs. aft. oper.* *Mins.*
0	12	Laparotomy, the region of the *4th and 5th* ganglia is free on both sides, then cut between above 2. ganglia on the *left* side.				
0	13	38°.c(28°)	7.058.	24.000.	16.942.	1
0	20	38°.c(28°)	8.000.	15.384.	7.384.	8
0	25	38° (28°)	8.275.	17.142.	8.867.	13
0	30	38° (28°)	8.108.	15.000.	6.892.	18
0	40	38° (28°)	8.000.	14.457.	6.457.	28
0	45	38° (28°)	8.000.	13.953.	5.953.	33
0	50	38° (28°)	7.185.	13.043.	5.858.	38

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24/V 24. **EXP. II.** *Sympathectomy.*

No. 2 dog ♀ Wt. 4.00 Kgm.

(Sympathectomy between the *4th and 5th*; the *5th and 6th* ganglia on the *left side.*)

Hrs. A.M.	*Mins.*	*B.H.* (*R.T.*)	*Blood-flow per min. C.C.* *R.*	*L.*	*Diff.*	*Past hrs. aft. oper.* *Hrs.*	*Mins.*
12 P.M.	00	33°.c(19°.8)	1.655.	5.200.	3.545.	21	30
2	00	31°.5(20°)	1.476.	4.000.	2.524.	23	30
2	10	31°.5(20°)	1.476.	3.428.	1.952.	23	40
2	20	31°.5(20°)	1.090.	3.000.	1.910.	23	55
2	35	31°.5(20°)	1.059.	2.666.	1.607.	24	05
2	45	31°.5(20°)	1.010.	2.042.	1.032.	24	15

Sympathectomy (betw. the *4th and 5th, 5th and 6th* gang. on the *left* side.)

23/V. **EXP. III.** *3 days after the operation.*

No. 3 dog ♀ Wt, 6.00 Kgm.

Hrs. P.M.	*Mins.*	*B.H.* (*R.T.*)	*Blood-flow per min. C.C.* *R.*	*L.*	*Diff.*
3	00	35°.5c 20°)	2.285.	6.000.	3.705.
3	15	36° (20°)	2.000.	5.274.	3.274.
3	30	36° (20°)	1.745.	3.436.	1.691.

Sympathectomy (betw. the *4th and 5th, 5th and 6th* ganglia on the *left side.*)

23/V. **EXP. IV. A.** *4 days after the operation.*

No. 4a dog ♀ Wt. 6.20 Kgm.

			Blood-flow per min. C.C.			*Past hrs. aft. oper.*	
Hrs. A.M.	*Mins.*	*B.H. (R.T.)*	*R.*	*L.*	*Diff.*	*Hrs.*	*Mins.*
11	30	38°.5c(20°)	6.000.	15.627.	9.627.		
12 P.M.	00	38°.5(20°.5)	4.848.	11.951.	7.103.		
0	30	38°.5(21°)	4.971.	12.000.	7.029.		
1	00	Sympathectomy betw. the *2nd and 3rd* gang. on the *right.*					
3	25	37° (22°)	12.000.	8.000.	4.000.	2	25
4	00	37° (22°)	9.600.	6.681.	2.919.	2	35
5	00	36°.5(22°)	7.680.	5.760.	1.920.	3	35
		Sympathectomy (betw. the *4th and 5th*, *5th and 6th* ganglia on the *left* side.)					

9/VI. **EXP. IV. B.** *4 days after the operation.*

No. 4b dog ♀ Wt. 5.50 Kgm.

			Blood-flow per min. C.C.			*Past hrs. aft. oper.*	
Hrs. A.M.	*Mins.*	*B.H. (R.T.)*	*R.*	*L.*	*Diff.*	*Hrs.*	*Mins.*
11	15	37°.5(21°.8)	4.511.	5.882.	1.371.		
11	20	37°.5(22°)	4.166.	5.882.	1.716.		
11	25	37° (22°)	4.054.	5.538.	1.484.		
11	40	Laparotomy, the region of the *4th, 5th and 6th* gang. is free on both sides.					
11	50	37° (22°)	2.985.	4.054.	1.069.		
11	55	37° (22°)	2.323.	3.750.	1.427.		
12 P.M.	00	Sympathectomy, betw. the *3rd and 4th, 4th and 5th* gang. on the *right* side.					
0	05	37° (22°.5)	5.333.	3.680.	1.653.(R.+)	1	05
0	15	37° (22°.5)	4.838.	3.260.	1.578.	1	15
0	25	37° (22°.5)	4.705.	3.333.	1.372.	1	25
1	00	37° (22°.5)	2.891.	2.666.	0.225.	2	00
1	05	37° (22°.5)	2.790.	2.553.	0.237.	2	05
		Sympathectomy (betw. the *6th and 7th* gang, on the *left* side.)					

21/V. **EXP. V.** *5 days after the operation.*

No. 5 dog ♀ 6.50 Kgm.

			Blood-flow per min. C.C.		
Hrs. P.M.	*Mins.*	*B.H. (R.T.)*	*R.*	*L.*	*Diff.*
1	15	35°.5(17°.5)	6.193.	14.000.	7.807.
1	30	35°.5(17°.5)	5.587.	12.065.	6.478.
2	30	35° (17°)	5.485.	10.202.	4.717.
		Sympathectomy (betw. the ***4th and 5th***, *5th and 6th* ganglia on the *left* side.			

30/IV 24. **EXP. VI.** *6 days after the operation.*

No. 6 dog ♀ Wt. 4.50 Kgm.

(This dog was very weak, and its body heat was comparatively low.)

			Blood-flow per min. C.C.		
Hrs. P.M.	*Mins.*	*B.H. (R.T.)*	*R.*	*L.*	*Diff.*
2	15	——	1.200.	2.666.	1.466.
2	30	——	1.411.	2.181.	0.770.
3	00	28°.c(19°.3)	1.090.	1.714.	0.624.
3	30	28° (19°.3)	0.980.	1.714.	0.734.
		Sympathectomy (betwn. the *5th and 6th* gang. on the *left* side.)			

17/V. **EXP. VII.** *7 days after the operation.*

No. 7 dog ♀ Wt. 12.00 Kgm.

Hrs.	*Mins.*	*B.H. (R.T.)*	*Blood-flow per min. C.C. R.*	*L.*	*Diff.*	*Past hrs. aft. oper. Hrs.*	*Mins.*
P.M.							
0	30	38°.c(19°)	4.800.	13.043.	8.243.		
1	00	37°.5(19°)	4.571.	12.000.	7.667.		
1	10	37°.5(19°)	4.064.	11.636.	7.542.		
1	30	Now, the Sympathectomy on the *right* side is in the same *state* as on the left.					
3	45	37°.5(19°.5)	9.600.	6.020.	3.600.	2	15
4	15	37°.5(19°.5)	7.757.	4.592.	3.165.	2	45
5	30	37°.5(19°.5)	6.165.	3.733.	2.432.	4	00

To sum up the results of the foregoing experiments.

As regards Experiments IV b, in this former case where the sympathetic trunk was cut on the right side between the 2nd and 3rd ganglia, the colour of blood became remarkably bright 2 hours and 25 minutes after the operation and there was a considerable increase in blood-flow on the right side, it going to as much as 12.000 ccs, whereas there was an equally considerable decrease on the left side (8.000 ccs.), so that there was a difference of 4.000 ccs. between both sides.

In the latter case (Experiment IV b), where sympathectomy was effected on the right side between the 3rd and 4th ganglia, a change similar to what took place in the case of Experiment IV a was witnessed on the right side 65 minutes after the operation. Thus, there was then a great increase in blood-flow compared with 11.15 a.m., the rate being 5,333 ccs., whereas on the left side it was 3,689 a figure much less than had been obtained before, the difference being thus reduced to 7,653 cc.–that is–about the same difference as that which had existed between both sides in respect of blood-flow at 11.20 a.m.

The considerable increase in blood-flow on the right side in both of these experiments after the cutting of the sympathetic trunk on the same side was probably due to the cessation of the action of the vasoconstrictor; but that this increase in blood-flow was in some measure counteracted by the laparotomy will be distinctly realized by a reference to the decrease in blood-flow on the left side (see Experiment I No. 1 a, b and c). It is hardly necessary

to add that due allowance should also be made for the effect of the sympathectomy previously made on the left side.

The increase in blood-flow on the right side in Experiment VII is also to be explained in the same manner as in the cases of the above experiments, I believe.

But why is it that the rate of blood-flow was not equal on both sides, as above stated, despite the fact that sympathectomy was effected on both sides exactly under the same condition?

I think that this is to be accounted for by the difference in the time which elapsed after the operation between the right and the left sides.

Sympathectomy (betw. the *4th and 5th, 5th and 6th* Ganglia on the ***left***.

13/VI. **EXP. VIII.** *8 days after the operation.*

No. 8 dog ♀ Wt. 4.50 Kgm.

Hrs. P.M.	*Mins.*	*B.H.* (*R.T.*)	*Blood-flow per min. C.C.* *R.*	*L.*	*Diff.*
2	00	37°.5c(24°)	8.943.	13.333.	4.390.
2	10	37°.5 (23°)	8.000.	12.765.	4.765.
2	20	37°.5 (23°)	7.500.	12.244.	4.744.
2	30	37°.5 (23°)	7.500.	12.244.	4.744.
2	40	37°.5 (23°)	6.060.	12.000.	5.940.
2	50	37°.5 (23°)	5.309.	10.000.	4.691.

Sympathectomy (betw. the ***4th*** *and* ***5th***, *5th* ***and 6th*** ganglia on the ***left*** side.)

11/VI. **EXP. IX.** *11 days after the operation.*

No. 8 dog ♀ Wt. 8.60 Kgm.

Hrs. P.M.	*Mins.*	*B.H.* (*R.T.*)	*Blood-flow per min. C.C.* *R.*	*L.*	*Diff.*
5	50	36°.5c(24°.5)	10.909.	24.000.	13.091.
6	00	36°.5 (24°.5)	10.909.	23.076.	12.167.
6	10	36°.5 (24°.5)	10.434.	20.000.	9.566.
6	15	36°.5 (24°.5)	10.434.	20.000.	9.566.
6	30	36° (24°.5)	10.909.	20.000.	9.091.
7	15	36° (24°.5)	10.909.	20.000.	9.091.
7	20	36° (24°.5)	10.909.	17.142.	6.233.

Sympathectomy (betw. the ***4th*** *and* ***5th***, *5th and 6th* on the ***left*** side.)

11/VI. **EXP. X.** *14 days after the operation.*

No. 10 dog ♀ Wt. 8.85 Kgm.

Hrs. A.M.	*Mins.*	*B.H.* (*R.T.*)	*Blood-flow per min. C.C.* *R.*	*L.*	*Diff.*
11	45	38°.c(22°)	7.317.	23.076.	15.959.
11	55	38° (22°.5)	6.857.	20.689.	13.832

P.M.					
0	05	38° (22°.5)	6.451.	22.222.	15.771.
0	30	38° (23°)	6.000.	22.222.	16.222.
1	00	38° (23°)	5.217.	20.000.	14.783.

Sympathectomy (betw. the *4th and 5th*, *5th and 6th* on the ***left*** side.)

11/VI. **EXP. XI.** *14 days after the operation.*

No. 11 dog ♀ Wt. 6.70 Kgm.

Blood-flow per min. C.C.

Hrs.	*Mins.*	*B.H. (R.T.)*	*R.*	*L.*	*Diff.*
P.M.					
3	00	39°.c(24°)	8.571.	12.000.	3.429.
3	10	39° (24°)	7.407.	10.909.	3.502.
3	20	39° (24°)	6.666.	10.169.	3.503.
3	30	39° (24°)	6.153.	10.169.	4.016.
3	40	39° (24°)	5.454.	10.000.	4.546.

Sympathectomy (betw. the *4th and 5th* gang. on the ***left*** side.

4/V. **EXP. XII.** *15 days after the operation.*

No. 12 dog ♀ Wt. 6.77 Kgm.

Blood-flow per min. C.C.

Hrs.	*Mins.*	*B.H. (R.T.)*	*R.*	*L.*	*Diff.*
A.M.					
11	00	37°.5c(13°.5)	12.000.	16.000.	4.000.
11	30	——	11.631.	14.000.	2.369.
11	45	37°.5 (13°.5)	8.369.	10.381.	2.012.

Sympathectomy (betw. the *4th and 5th* ***5th*** *and 6th* on the ***left*** side.)

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19/VI. **EXP. XIII.** *22 days after the operation.*

No. 13 dag ♀ Wt. 16.00 Kgm.

Blood-flow per min. C.C.

Hrs.	*Mins.*	*B.H. (R.T.)*	*R.*	*L.*	*Diff.*
P.M.					
0	30	37°.5c(24°)	10.000.	30.000.	20.000.
0	40	37°.5 (24°)	8.571.	28.571.	20.000.
0	50	37°.5 (24°)	8.108.	27.272.	19.164.

Sympathectomy (betw. the *5th and 6th* ganglia on the left side.)

13/VI. **EXP. XIV. A.** *30 days after the operation.*

No. 14a dog ♀ Wt. 7·20 Kgm.

Blood-flow per min. C.C.

Hrs.	*Mins.*	*B.H. (R.T.)*	*R.*	*L.*	*Diff.*
P.M.					
3	00	37°.2c(23°)	4.878.	20.000.	15.122.
3	10	37°.2 (23°)	4.545.	18.461.	13.916.
3	20	37°.2 (23°)	4.411.	18.461.	14.050.
3	30	37°.2 (23°)	4.444.	18.750.	14.306.
3	40	37°.2 (23°)	4.109.	17.142.	13.033.

Sympathectomy (betw. the *1st and 2nd*, *2nd and 3rd* gang. on the ***left*** side.)

17/XII 23. **EXP. XIV. B.** *30 days after the operation.*

No. 14b dog ♀ Wt. 3.40 Kgm.

Blood-flow per min. C.C.

Hrs.	*Mins.*	*B.H. (R.T.)*	*R.*	*L.*	*Diff.*
A.M.					
11	00	34°.c(13°.4)	3.370.	4.040.	0.670.
11	20	34°.5(13°.5)	3.727.	4.442.	1.715.

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Sympathectomy (betw. the *3rd and 4th* gang. on the *left* side.

21/V. **EXP. XV.** *43 days after the operation.*

No. 15 dog ♀ Wt. 6.00 Kgm.

Hrs. P.M.	*Mins.*	*B.H.* (*R.T.*)	*Blood flow per min. C.C.* *R.*	*L.*	*Diff.*
4	20	34°.5c(18°)	12.000.	21.600.	9.600.
4	45	33°.7 (17° 5)	12.000.	18.830.	6.830.
5	00	34°.5 (17°.5)	8.470.	16.000.	7.530.

Sympathectomy (betw. the *5th and 6th* gang. on the *left* side.)

27/VII. **EXP. XVI.** *66 days after the operation.*

No. 16 dog ↕ Wt. 12.70 Kgm.

Hrs. A.M.	*Mins.*	*B.H.* (*R.T.*)	*Blood-flow per min. C.C.* *R.*	*L.*	*Diff.*
11	00	39°.c(32°)	12.631.	18.181.	5.550.
11	10	39° (33°)	13.333.	17.647.	4.314.
11	20	39° (33°)	13.043.	17.142.	4.099.
11	30	39° (34°)	13.043.	17.142.	4.099.
11	40	39° (34°)	13.333.	18.461.	5.128.
11	50	39° (35°)	13.043.	18.181.	5.138.
12	00	39° (35°)	13.333.	18.181.	4.848.

Sympathectomy (betw. the *5th and 6th* gang. on the *left* side.)

20/VII. **EXP. XVII.** *88 days after the operation.*

No. 17 dog ♀ Wt. 7.60 Kgm.

Hrs. A.M.	*Mins.*	*B.H.* (*R.T.*)	*Blood-flow per min. C.C.* *R.*	*L.*	*Diff.*
9	50	36°.c(28°)	3.000.	3.333.	0.333.

In this case experiment was made when the dog was on the verge of death, beginning with the right side. The animal died soon after this first experiment, which, however, showed a slight increase in blood-flow on the operated side.

From this it would appear that if the dog had continued in a vigorous state, the rate of blood-flow on the left side would have been found by far greater.

Sympathectomy (betw. the *4th and 5th* on the *left* side.)

12/VI. **EXP. XVIII.** *192 days after the operation.*

No. 18 dog ♀ Wt. 10.50 Kgm.

Hrs. P.M.	*Mins.*	*B.H.* (*R.T.*)	*Blood-flow per min. C.C.* *R.*	*L.*	*Diff.*
3	30	35°.5c(26°.5)	9.375.	20.000.	10.625.
3	40	35°.5 (26°.5)	9.836.	20.000.	10.164.
4	00	35°.5 (26°.5)	7.058.	18.461.	10.403.
4	10	35°.5 (26°.5)	6.741.	17.647.	10.906.
4	20	35°.5 (26°.5)	6.896.	17.142.	10.246.
4	30	35°.5 (26°.5)	6.857.	16.000.	9.143.

Sympathectomy (betw. the *3rd and 4th* gang. on the *left* side.)

30/VII. **EXP. XIX.** *248 days after the operation,* (*Fig.*)

No) 19 dog ↕ Wt. 11.50 Kgm.

		Blood-flow per min. C.C.			
Hrs.	Mins.	B.H. (R.T.)	R	L.	Diff.
A.M.					
11	00	38°.5c(32°)	9.600.	16.000.	6.400.
11	05	38 .5c(32°)	9.600.	13.714.	4.114.
11	15	38°.5 (32°)	10.000.	13.333.	3.333.
11	20	38°.5 (32°)	9.230.	12.000.	2.770.
11	25	38°.5 (33°)	9.230.	11.764.	2.534.
11	30	38°.5c(33°)	8.823.	11.549.	2.726.
11	35	38°.5 (34°)	8.571.	11.428.	2.857.
11	40	38°.5 (34°)	8.108.	10.909.	2.801.
11	45	38°.5 (34°)	7.741.	10.000.	2.259.
11	50	38°.5 (34°)	7.500.	10.000.	2.500.
11	55	38°.5 (35°)	6.896.	9.375.	2.479.
12	00	38°.5 (35°)	6.896.	9.230.	2.334.

It is now time for me to have a general survey of the results of the 20 foregoing experiments (Nos. II–XIX).

Experiments II, III, IV, VI, VIII, IX, X, XI and XIII were made to ascertain the results of sympathectomy effected between the 4th and 5th and the 5th and 6th ganglia, always on the left side, but at different periods after the operation.

They would seem to show that the difference (in blood-flow) between the operated side and the other was entirely unaffected by the weight of the animal and the length of time elapsed after the operation, for while the difference was in one instance found to be about 20,000 ccs. many days after the operation, it was only about 3.500 ccs. in one case and 1.400 ccs. in another even when a comparatively few days had elapsed after the operation. More especially, in Experiments IVA and IVB, in which sympathectomy was effected between the same ganglia on both sides and the result was examined 4 days after the operation, the maximum difference between both sides was observed to be about 9.600 ccs. in the case of experiment IVA and about 1.700 ccs. in the case of IVB.

From these experiments it would appear that the anatomical condition of sympathecticnervous fibres to the hind limb differs between different dogs.

I then made Experiment XX in order to see what change would be brought about (by sympathectomy) on the same height or different parts on the right and the left side of the same animal.

Sympatnectomy (betw. the *6th and 7th* ganglia on *both* sides.)

27/VIII. **EXP. XX. A.**

No. 20a dog ♀ Wt. 5.20 Kgm.

Blood-flow per min. C.C.

Hrs. P.M.	*Mins.*	*B.H.* (*R.T.*)	*R.*	*L.*	*Diff.*
3	40	39°.8c(30°)	6.818.	7.142.	0.324. (L.+)
4	00	Laparotomy and sympathectomy, betw. the *6th and 7th* ganglia, on both sides, the *left* at first and 3 minutes after on the right side.			
4	45	39°.8 (30°)	15.000.	14.285.	0.715. (R.+)
4	50	39°.8 (30°)	15.000.	15.000.	0.
4	55	39°.8 (30°)	15.789.	15.789.	0.
5	00	39°.8 (30°)	15.789.	15.000.	0.789. (R.+)

Sympathectomy (the *Right* side: betw. the *5th and 6th, 6th and 7th,* the *left* side: betw. the *4th and 5th, 5th and 6th.*

7/VI. **EXP. XX. B.** *3 days after the operation.*

No. 20b dog ♀ Wt. 6.85 Kgm.

Blood-flow per min. C.C.

Hrs. A.M.	*Mins.*	*B.H.* (*R.T.*)	*R.*	*L.*	*Diff.*
11	20	36°.5c(19°.5)	5.940.	6.122.	0.182. (L.+)
11	40	36°.5 (19°.5)	5.109.	5.333.	0.224.
11	50	36°. (19°.5)	4.838.	5.504.	0.666.
12 P.M.	10	36°. (19°.5)	4.800.	5.454.	0.654.

Sympathectomy (the *Right* side: betw. the *4th and 5th,* 5th and 6th. The *left* side: betw. the *3rd and 4th, 4th and 5th.*

7/VI. **EXP. XX. C.** *3 days after the operation.*

No. 30c dog ♀ Wt. 8.80 Kgm.

Blood-flow per min. C.C.

Hrs. P.M.	*Mins.*	*B.H.* (*R.T.*)	*R.*	*L.*	*Diff.*
2	10	37°.5(21°)	14.769.	14.769.	0.
2	40	37°. (21°)	13.333.	13.765.	0.432. (L.+)
2	55	37° (21°)	12.500.	12.765.	0.265.
3	15	36°.8(21°)	11.111.	11.538.	0.427.
3	40	36°.8(21°)	10.000.	10.162.	0.162.

Of the foregoing experiment, Experiment No. 20a showed that the anatomical condition of sympathetic nerve fibres going from the region between the 6th and 7th ganglia to the foot was almost equal on both sides, whereas Experiment No. 20b showed that a larger number of nervous fibres seemed to go out from the region between the 6th and 7th ganglia and Experiment No. 20c that more nervous fibres seemed to emanate from between the 3rd and 4th ganglia than from between the 5th and 6th. But these results having been obtained from a comparison of the right and left sides of a few animals, it is hardly necessary to add that they have to be verified by many more experiments before they can be offered as a general statement covering all cases.

Comparison Between Periarterial Sympathectomy and Abdominal Sympathectomy in respect of their Effect upon Blood-Flow.

According to my experiments, (1) the increase in blood-flow is by far greater in the case of abdominal sympathectomy. (2) The effect of abdominal sympathectomy appears to be of much longer duration.

It may then be asked what produces these difference between the two?

As sympathetic nerve fibres reach the artery of the lower limb at intervals along their course, it would seem hard to obtain satisfactory results by effecting periarterial sympathectomy at a limited part. My experiments on animals and clinical examples showed its effect to be only of short duration, as stated above. Nor was it possible completely to denude the adventitia which is supposed to contain the main vasoconstric fibres.

Morever, owing to the cicatrisation after the operation produced in a short time, the effect of the operation was lost.

On the other hand, I was able by means of abdominal sympathectomy completely to cut off, at a point, the course of communication of the sympathetic system to the periphery.

I further found that this operation was calculated to obviate all troubles attendant upon periarterial sympathectomy, that is, injuries to the wall of vessels, the perforation (W. Milko) that is liable frequently to occur after the operation and, lastly, the cicatrisation that is produced in the operated space.

For these reasons I would recommend abdominal sympathectomy rather than Leriche's operation for spontaneous gangraen and other diseases of the same nature, although I have not yet had any opportunity to clinically test this theory of mine.

Conclusion.

1. In case the abdominal sympathetic trunk is cut, the blood in the veins presents a deep crimson colour (as Werzihoff says) and the rate of blood-flow rapidly increases.

Daijo Kobayashi.

The increase lasts about 3 minutes next following the operation, after which time the rate of blood-flow shows a considerable abatement, though it is by far greater than on the non-operated side, the rate on the operated side ranging between 0.900 c.c. (Experiment No. 1a) and 20.000 ccs, (Experiment No. 13). And this difference between the two sides is by far greater in the case of abdominal sympathectomy than in the case of periarterial sympathectomy.

2. The increase in the rate of blood-flow after abdominal sympathectomy seems to be almost unaffected by a longer or shorter period of time that has elapsed after the operation. This is to say, it seems to last a very long time.

3. In the light of my experiments in which the abdominal sympathetic trunk was cut at one or two points in different regions between the 1st and 7th lumbar ganglia, I believe that it is practicable by this means completely to cut off the communication between the sympathetic centrum and the periphery in a given point.

Specimen of the dog (Experiment XIX.)

A and B are cut-ends of the left abdominal sympathetic trunk (betw. the 3rd and 4th ganglia). C is the right sympathetic trunk.

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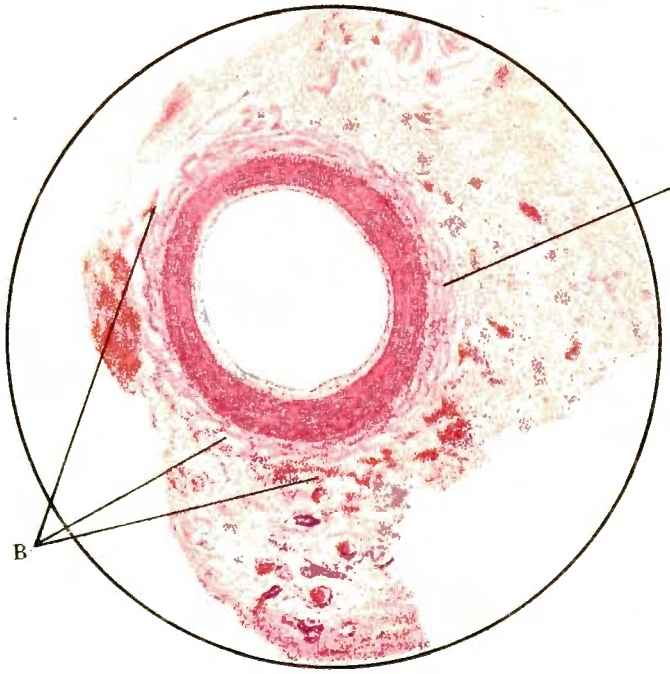

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